

| ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)  |                            |  |  |  |                     | February 2002       |                     |                     |                     |                     |
|---|----------------------------|--|--|--|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| BUDGET ACTIVITY<br>2 - Applied Research   |                            |  |  | PE NUMBER AND TITLE<br>0602303A - MISSILE TECHNOLOGY |                     |                     |                     |                     |                     |                     |
| COST (In Thousands)   |                            |  |  | FY 2001<br>Actual                                    | FY 2002<br>Estimate | FY 2003<br>Estimate | FY 2004<br>Estimate | FY 2005<br>Estimate | FY 2006<br>Estimate | FY 2007<br>Estimate |
| Total Program Element (PE) Cost   |                            |  |  | 71056  | 61085               | 31884               | 36743               | 39208               | 39965               | 40819               |
| 214   | MISSILE TECHNOLOGY         |  |  | 49990  | 54635               | 31884               | 36743               | 39208               | 39965               | 40819               |
| 223   | AERO-PROPULSION TECHNOLOGY |  |  | 18266  | 6450                | 0                   | 0                   | 0                   | 0                   | 0                   |
| 340   | SWORD                      |  |  | 2800   | 0                   | 0                   | 0                   | 0                   | 0                   | 0                   |
| <p><b><u>A. Mission Description and Budget Item Justification:</u></b>This applied research program element investigates advanced technologies for missiles, rockets, and unmanned vehicles for use on the Objective Force, including the Future Combat Systems (FCS). Major technology areas include missile guidance systems, air defense acquisition systems, multi-spectral seekers, high fidelity simulations, missile aerodynamics and structures, and missile propulsion. The overall objectives are to increase the survivability of launch systems; provide greater lethality and effectiveness under adverse battlefield conditions; increase kill probabilities against diverse targets; and provide powerful new simulation and virtual prototyping analysis tools. As Compact Kinetic Energy Missile (CKEM) technologies mature, demonstrations will be conducted under PE 0603313A (Missile and Rocket Advanced Technology). The CKEM program transitions in FY02-03 to the advanced technology demonstration phase. Another effort in this PE is the high-g, low cost, Micro Electro-Mechanical Systems (MEMS) Inertial Measurement Unit (IMU) program. This effort will provide MEMS IMU's for precision guidance of missile and munitions. This program is a collaboration with the Armament Research and Development and Engineering Center. The MEMS IMU effort is funded by a combination of applied research and mantech funding. Funding has been increased in FY02-05 and FY07 to complete the design, demonstration, and testing for this effort.</p> <p>Work in this program element is related to, and fully coordinated with, efforts in PE 0602702E (Tactical Technology), PE 0602602F (Conventional Munitions), PE 0603601F (Conventional Weapons Technology), PE 0601104A (University and Industry Research Centers), PE 0603313A (Missile and Rocket Advanced Technology), PE 0603654A (LOSAT Advanced Concept Technology Demonstration), PE 0602782A (Command, Control and Communications (C3) Technology), PE 0605601A (Army Test Ranges and Facilities) and PE 0708045A (Industrial Preparedness). The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan (AMP) and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is performed by the Aviation &amp; Missile Research, Development, and Engineering Center, U.S. Army Aviation and Missile Command, Redstone Arsenal, AL. This PE supports the Objective Force transition path of the Transformation Campaign Plan (TCP).</p> |                            |  |  |  |                     |                     |                     |                     |                     |                     |

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**2 - Applied Research**PE NUMBER AND TITLE  
**0602303A - MISSILE TECHNOLOGY****B. Program Change Summary**

|  | FY 2001 | FY 2002 | FY 2003 |
|--|---------|---------|---------|
| Previous President's Budget (FY2002 PB)        | 70035   | 40112   | 31872   |
| Appropriated Value                             | 70683   | 61612   | 0       |
| Adjustments to Appropriated Value              | 0       | 0       | 0       |
| a. Congressional General Reductions            | 0       | -527    | 0       |
| b. SBIR / STTR                                 | -1779   | 0       | 0       |
| c. Omnibus or Other Above Threshold Reductions | 0       | 0       | 0       |
| d. Below Threshold Reprogramming               | 2800    | 0       | 0       |
| e. Rescissions                                 | -648    | 0       | 0       |
| OSD Realignment                                | 0       | 0       | 0       |
| Adjustments to Budget Years Since FY2002 PB    | 0       | 0       | 12      |
| Current Budget Submit (FY 2003 PB )            | 71056   | 61085   | 31884   |

Change Summary Explanation:

Significant Changes:

FY02 - Congressional Adds totaling \$21.5M, as noted below, added to this PE

Congressional Adds:

FY02 - Congressional adds were made for Low Cost Guidance and Navigation Unit, Project 214 (\$5000); Accelerated Dev/Test Tactical Missile Components, Project 223 (\$3000); MEMS IMU-GPS, Project 214 (\$7000); CKEM IMU, Project 214 (\$1000); Loitering Attack Munition for Aviation, Project 214 (\$2000); and Jet Interaction FCD Testbed, Project 223 (\$3500)

Projects with no R2-A:

Project 223 - Aero Propulsion Technology

- (\$3000) Accelerated Dev/Test Tactical Missile Components, Project 223: The objective of this one-year Congressional Add is to design, develop and test advanced missile components for hypervelocity missile airframes. No additional funding is required to complete this project.

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| <p>- (\$3500) Jet Interaction FCD Testbed, Project 223: The objective of this one-year Congressional Add is to pursue hypersonic missile technology. No additional funding is required to complete this project.</p> |  |               |

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| BUDGET ACTIVITY<br>2 - Applied Research   |                    |  | PE NUMBER AND TITLE<br>0602303A - MISSILE TECHNOLOGY |                     |                     |                     | PROJECT<br>214      |                     |                     |
| COST (In Thousands)   |                    |  | FY 2001<br>Actual                                    | FY 2002<br>Estimate | FY 2003<br>Estimate | FY 2004<br>Estimate | FY 2005<br>Estimate | FY 2006<br>Estimate | FY 2007<br>Estimate |
| 214   | MISSILE TECHNOLOGY |  | 49990  | 54635               | 31884               | 36743               | 39208               | 39965               | 40819               |
| <p><b><u>A. Mission Description and Budget Item Justification:</u></b>This project focuses on missile and rocket technologies that support lightweight, highly lethal weapons concepts with greatly reduced logistics requirements for the FCS and Objective Force. Major technology areas investigated are missile guidance systems, air defense target acquisition systems; multi-spectral seekers; high fidelity simulations; missile aerodynamics and structures; and missile propulsion. Research objectives are to enhance the survivability of launch systems, provide greater effectiveness under adverse battlefield conditions, increase kill probabilities against diverse targets, and provide powerful new simulation and virtual prototyping analysis tools. The major effort in this project is the CKEM. This missile is a prime candidate to provide overwhelming lethality for the FCS Direct Fire System with increased stowed rounds. The funding for this program was increased in FY01 and FY02 to accelerate component testing to ensure that a prototype is ready in FY04. As efforts in this project mature, work is transitioned to PE 0603313A (Missile and Rocket Advanced Technology) to support demonstrations of capabilities for CKEM and Common Missile. Another effort in this project is the high-g, low cost, MEMS IMU program. This effort will provide MEMS IMU's for precision guidance of missile and munitions. This is a joint program with the Armament Research and Development and Engineering Center. The MEMS IMU effort is funded by a combination of applied research and mantech funding. Funding has been added in FY02-07 to complete the design, demonstration, and testing for the MEMS IMU effort. Major contractors are Lockheed Martin, Dallas, TX; MILTEC/Boeing, Huntsville, AL; Raytheon Company, Tucson, AZ; and BAE Systems, Austin, TX. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).</p> |                    |  |  |                     |                     |                     |                     |                     |                     |
| <p><b><u>FY 2001 Accomplishments:</u></b></p> <ul style="list-style-type: none"><li>18819 - CKEM - Awarded three contracts to mature the system design concepts and validate component technology.<br/>- CKEM - Performed detailed design using the emerging results from the technology and component development effort. Defined technical risk and develop a risk reduction plan; developed cost breakouts for elements; and developed objective/thresholds for key performance parameters in a Cost as an Independent Variable (CAIV) strategy.<br/>- CKEM - Performed system trades and assessments utilizing both 6-Degrees-of-Freedom and Force-on-Force models.</li><li>6897 - High-G MEMS IMU - Performed research to mature sensor and electronic design, foundry processes, and testing at competing contractor facilities for advancement of affordable, high-G MEMS IMUs. This technology is applicable to 90% of DOD requirements from both high-g; gun launched precision munitions and high performance guided missiles. This is a cooperative Industry/Government program jointly managed by the gun and missile communities. Three contracts have been awarded to industry.</li></ul>   |                    |  |  |                     |                     |                     |                     |                     |                     |

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| BUDGET ACTIVITY<br>2 - Applied Research             | PE NUMBER AND TITLE<br>0602303A - MISSILE TECHNOLOGY   | PROJECT<br>214 |
| <b><u>FY 2001 Accomplishments: (Continued)</u></b>  |  |                |
| • 7443  | <p>- Missile guidance systems - Developed a prototype MEMS-based roll rate sensor and laboratory tested it over limited military environments. Used collected data in flight simulations and performance assessments for applicability of ATR to relevant weapon systems. Tested infrared imaging counter-countermeasures.</p> <p>- High fidelity system level simulations and aerodynamics - Investigated infrared (IR) target signature models applicable to active IR target acquisition and tracking sensors. Devise methods and wrote software for representing 3-dimensional target geometry models applicable to active IR sensors where signal polarization may be a processing discriminant. Investigated methods of projecting hardware -in-the-loop (HWIL) in-band IR target images and scenes with adequate scene detail and dynamic range to include the effects of active and passive IR countermeasures. Completed and demonstrated the target verification monitor with application to all types of Ka-band pulse and continuous wave (CW) radiation in a HWIL simulation facility.</p>                                      |                |
| • 12398   | <p>- Smart, stealthy, smokeless missile propulsion and smart structures - Completed component maturation of flight type hardware and integrated into a brassboard. Tested a flexible sustainer for long range, survivable, multi-mission capabilities. Completed vacuum aging study for service life prediction for cost avoidance of replacing propulsion systems and increased system safety and performance reliability. Devised methodology for aging assessment of gel propulsion systems.</p> <p>- Focused technology integration - Designed a digital system manager (DSM) and integrated with the sensor suite to optimize power consumption, and finalized and validated limited failure models for Remote Readiness Asset Prognostics/Diagnostics System (RRAPDS). Completed design to provide real-time targeting for short/medium range indirect fire munitions using a miniature (45-60 centimeter wingspan) aerial vehicle. Selected approach and completed bench test prototype hardware to adapt the Defense Advanced Research Projects Agency (DARPA) Netfires Loitering Attack Munition (LAM) to rotary wing aircraft.</p> |                |
| • 4433  | <p>- One year Congressional add to complete Low Cost Guidance and Navigation Unit fabrication of a prototype navigator including synchronous sampling, ultra-tightly coupled Global Positioning System/Inertial Measurement Unit (GPS/IMU), and full set of navigator functions able to meet Extended Range Gun Munition (ERGM) and XM982 155mm Extended Range Artillery Projectile form factors as well as those of larger missiles/vehicles.</p>   |                |
| Total 49990   |  |                |

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| <p><b><u>FY 2002 Planned Program</u></b></p> <ul style="list-style-type: none"> <li>10300 - CKEM - Fabricate and test subsystems to define a basis for determining risk, achievable performance, and trade-offs between lethality/survivability and missile sizing.<br/>- CKEM - Perform hardware -in-the-loop simulation testing under flight representative conditions to assess and reduce risk. Achieve a Technology Readiness Level (TRL) of 5.<br/>- CKEM - - Provide test results and assessments for transition of program to a technology demonstration in FY03.</li> <li>1000 - CKEM - This one year congressional add is to provide risk reduction and develop an alternative design approach for the CKEM IMU.</li> <li>10000 - High-G MEMS IMU - Perform detailed design and analysis of first generation devices, incorporating emerging results from development effort. Construct, evaluate, and refine manufacturability processes to begin production automation and process control maturation.</li> <li>7000 - High-G MEMS IMU - This one year congressional add is to initiate development of a deeply integrated GPS/IMU.</li> <li>8625 - Missile guidance systems - Test MEMS-based angular rate sensors (ARSSs) that incorporate technology developed by DARPA. Test in the laboratory and in an extended military environment both the MEMS-based ARS and the single axis roll rate sensor. Design and develop optical test bed to evaluate advancements in uncooled detector technology. Investigate concept designs for uncooled IR sensor for missile applications.<br/>- High fidelity system level simulations and aerodynamics - Investigate designs for signal generation applicable to HWIL simulation of IR LADAR devices. Implement improved techniques for PC-based massively parallel computation of target RF signatures. Design and build databases of RF and IR target signatures suitable for multispectral HWIL simulation.</li> <li>3635 - Smart, stealthy, smokeless missile propulsion and smart structures - Complete design, fabricate and test brassboard of a deep throttling booster that extends the capabilities of controllable thrust technology to increase range and provide multi-mission capability for a family of FCS and Objective Force weapon systems.</li> <li>7075 - Focused technology integration - Integrate a "full-up" RRAPDS system which will have applicability to all tactical missiles to include CKEM, Common Missile, LAM, and LAM- Aviation (LAM-A). Evaluate RRAPDS as an HTI candidate for a launch platform and a high value conventional munition. Evaluate ability to provide the user with target information on stationary and moving military vehicles using small unmanned aerial vehicles. Define critical technologies for a 2.75 inch Advanced Miniature Multi-Role Precision Guided Missile (AMMPGM).</li> <li>5000 - One year Congressional add to perform prototype testing of a Low Cost Guidance and Navigation Unit which includes a deeply integrated Global Positioning System/Inertial Measurement Unit (GPS/IMU).</li> <li>2000 - One year Congressional add to fabricate and assemble long range loiter missiles airframe and seeker components. Initiate integration of prototype hardware for ballistic flight test.</li> </ul> <p>Total 54635</p> |   |                       |

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| <p><b><u>FY 2003 Planned Program</u></b></p> <ul style="list-style-type: none"> <li>• 10000 - High-G MEMS IMU - Provide IMUs for integration into high G Soft Recovery Vehicles and missile airframes for performance verification testing to determine risk and achievable performance. Test results will be one of the factors used to select vendors for continuation into the next phase of the program.</li> <li>• 9434 - Missile guidance systems - - Integrate MEMS-based angular rate sensors and roll rate sensor into a three-axis rate package, test and transition to FCS and industry. Design geometry transformations for rapid retraining of ATR that will allow precision strike of a target from a different direction than it was originally detected. Devise hardening techniques and algorithms for IR seekers to defeat laser countermeasures. Demonstrate concepts of advanced uncooled infrared seeker and sensor hardware. Model proof of concept devices and construct a one-dimensional array of MEMS temperature sensors for RRAPDS.<br/>- High fidelity system level simulations and aerodynamics - Design signal generation capability for IR LADAR HWIL simulation; design cold chamber background for IR target simulation; continue design and build of target signature databases.</li> <li>• 12450 - Smart, stealthy, smokeless missile propulsion and smart structures - Design, fabricate, and static test integrated deep throttling booster that extends the capabilities of controllable thrust technology to increase range and provide multi-mission capability for a family of FCS and Objective Force weapon systems.<br/>- Focused technology integration - Model two missile types and simulate the missile fire control automatic reconfiguration in a testbed; test a rail launch system to adapt the DARPA Netfires LAM to rotary wing aircraft. Establish best technical approach for key component technologies for AMMPGM.</li> </ul> <p>Total 31884</p> |   |                       |